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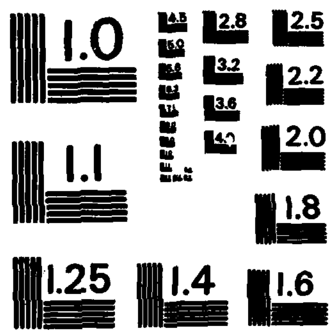

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SOPHISTICATED JAMMERS AND ADAPTIVE ARRAYS

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This report describes progress under Naval Air Systems Command Contract N00019-81-C-0093 during the fourth quarterly period. Research on the behavior of adaptive arrays with sophisticated jammers is summarized.

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I. INTRODUCTION

This report describes progress under Naval Air Systems Command Contract N00019-81-C-0093 for the fourth quarterly period. This REPORT ~~contract~~ involves studies on the effectiveness of two types of jamming against adaptive arrays: envelope modulated jammers and cross-polarized jammers. Our progress during the fourth quarter is described below.

II. PROGRESS

A. Envelope Modulated Jamming

During the last quarter we have continued studies on the effects of modulated jammers on adaptive arrays. A study of array performance with double-sideband amplitude modulated interference (with a carrier) has been completed. This problem was used to illustrate a general method we have developed for finding array behavior with arbitrary periodic envelope modulated interference.

In addition, during the last quarter, we have also found a way to handle interference with periodic phase modulation. Phase modulation leads to a more complicated mathematical problem than amplitude modulation. However, we have developed a technique that allows one to solve for the weight behavior when the interference has a periodic phase (or frequency) modulation. This technique may be used to evaluate the effects of signals such as swept CW jamming, for example. The only

limitation besides periodicity is that it must be possible to approximate the spectrum of the interference with a finite number of line frequencies.

As an initial test of the method, we have computed the response of the array to interference with sinusoidal phase modulation. The effect on array performance of each interference parameter (power, modulation frequency, modulation index and angle of arrival) has been evaluated.

B. Cross-Polarized Jamming

During the last quarter, a technical report has been published [1] on the performance of a tripole adaptive array (i.e., three mutually perpendicular dipoles at the same center) with cross-polarized jamming. ("Cross-polarized jamming" is jamming that consists of two independent signals transmitted on orthogonal polarizations. Such jamming is equivalent to two ordinary jamming signals that come from the same direction. It uses up two degrees of freedom in the array and is more difficult for the array to null than a single jammer.)

Although the performance of the tripole against this jammer is not as good as against a singly polarized jammer, it is nevertheless quite good. Moreover, the susceptibility of the array to this type of jamming is strongly affected by the desired signal polarization. We have shown [1] that a linearly polarized desired signal makes the array most susceptible to cross-polarized jamming, and a circularly polarized desired signal makes it least susceptible. By "least susceptible", we

mean that with a circularly polarized desired signal, a cross-polarized jammer will produce a poor output SINR from the array for the smallest range of jammer incidence angles.

C. Steering Vector Errors

During the last quarter we have published a report [2] on the effects of random steering vector errors in the Applebaum array. We had previously studied the effect of a simple beam pointing error on the Applebaum array [3]. However, it subsequently became clear that random steering vector errors are also a problem, and the effects are somewhat different from those of a pointing error. This work describes the effects of such errors.

III. PAPERS PUBLISHED

During this year, three papers submitted during the previous contract (N00019-80-C-0181) have appeared:

(1) R.T. Compton, Jr., "The Effect of Integrator Pole Position on the Performance of an Adaptive Array", IEEE Transactions on Aerospace and Electronic Systems, AES-17, 4 (July 1981), p. 598.

(2) R.T. Compton, JR., "A Method of Choosing Element Patterns in an Adaptive Array", IEEE Transactions on Antennas and Propagation, AP-30, 3 (May 1982), p. 489.

(3) R.T. Compton, Jr., "The Effect of a Pulsed Interference Signal on an Adaptive Array", IEEE Transactions on Aerospace and Electronic Systems, AES-18, 3 (May 1982) p. 297.

In addition, during the present contract (N00019-81-C-0093), two new papers have been submitted for publication:

(1) R.T. Compton, Jr., "The Effect of Random Steering Vector Errors in the Applebaum Adaptive Array", accepted for publication in IEEE Transactions on Aerospace and Electronic Systems.

(2) A.S. Al-Ruwais and R.T. Compton, Jr., "Adaptive Array Behavior with Sinusoidal Envelope Modulated Interference", submitted to IEEE Transactions on Aerospace and Electronic Systems.

REFERENCES

[1] R.T. Compton, Jr., "The Performance of a Tripole Adaptive Array against Cross-Polarized Jamming", Report 713603-8, October 1982, ElectroScience Laboratory, Department of Electrical Engineering, Ohio State University, Columbus, Ohio 43221; prepared under Contract N00019-81-C-0093 for Naval Air Systems Command.

[2] R.T. Compton, Jr., "The Effect of Random Steering Vector Errors in the Applebaum Adaptive Array", Report 713603-7, June 1982, ElectroScience Laboratory, Department of Electrical Engineering, Ohio State University, Columbus, Ohio 43221; prepared under Contract N00019-81-C-0093 for Naval Air Systems Command.

[3] R.T. Compton, Jr., "Pointing Accuracy and Dynamic Range in a Steered Beam Adaptive Array", IEEE Transactions on Aerospace and Electronic Systems, AES-16, 3 (May 1980), p. 280.